

WHAT IS CLAIMED IS:

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A signal processing system, comprising:
a voice exchange capable of exchanging voice signals between a network line and
a packet based network; and
a full duplex data exchange capable of exchanging data signals from the network
line with demodulated data signals from the packet based network.

2. The signal processing system of claim 1 further comprising a call discriminator
10 capable of discriminating between the voice signals and the data signals from the network line,
the voice exchange being enabled for the voice signals and the data exchange being enabled for
the data signals.

3. The signal processing system of claim 1 wherein the data signals from the
15 network line are modulated by a voiceband carrier, and the data exchange comprises a data pump
capable of demodulating the data signals from the network line for transmission on the packet
based network and remodulating the data signals from the packet based network with the
voiceband carrier for transmission on the network line.

4. The signal processing system of claim 3 wherein the data exchange comprises
20 a jitter buffer capable of receiving packets of the data signals of varying delay from the packet
based network and compensating for the delay variation of the data signal packets.

5. The signal processing system of claim 4 wherein the jitter buffer outputs an
isochronous stream of the received data signals.

25 6. The signal processing system of claim 4 wherein the data pump transmits the
received data signals to the network line at a transmit rate.

7. The signal processing system of claim 6 wherein the jitter buffer compensates for
30 the delay variation of the data signal packets by holding a number of the received data signals,
and wherein the data exchange further comprises a clock synchronizer which adaptively adjusts
the transmit rate of the data pump in response the number of the received data signals in the jitter
buffer.

8. The signal processing system of claim 6 wherein the jitter buffer compensates for
35 the delay variation of the data signal packets by holding a number of the received data signals,

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and wherein the data exchange further comprises spoof logic which provides spoof data to the data pump when the number of the received data signals held in the jitter buffer is below a threshold.

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9. The signal processing system of claim 1 wherein the voice exchange comprises a jitter buffer capable of receiving packets of the voice signals of varying delay from the packet based network and compensating for the delay variation of the voice signal packets.

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10. The signal processing system of claim 9 wherein the jitter buffer outputs an isochronous stream of the received voice signals.

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11. The signal processing system of claim 9 wherein the jitter buffer comprises a voice queue which buffers the received voice signals for a holding time, and a voice synchronizer which adaptively adjusts the holding time of the voice queue.

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12. The signal processing system of claim 11 further comprising a tone exchange capable of exchanging DTMF signals between the network line and the packet based network, the DTMF exchange comprising a DTMF queue capable of buffering packets of the DTMF signals from the packet based network, and a tone generator which generates a DTMF tone responsive to the buffered DMTF signals, the DMTF queue outputting a signal to the voice synchronizer to suppress the buffered voice signals when the DTMF signals are in the DTMF queue.

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13. The signal processing system of claim 1 wherein the voice exchange comprises a voice decoder capable of decoding packets of the voice signals from the packet based network for transmission to the network line, a voice activity detector which detects the voice signals without speech, and a comfort noise generator which inserts comfort noise in place of the voice signals without speech.

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14. The signal processing system of claim 13 wherein the voice exchange further comprises a comfort noise estimator which generates comfort noise parameters from at least a portion of the voice signals without speech, the comfort noise generator being responsive to the comfort noise parameters.

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15. The signal processing system of claim 1 wherein the voice exchange comprises a voice decoder capable of decoding packets of the voice signals from the packet based network for transmission to the network line, a voice activity detector which detects lost voice signals,

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and a lost packet recovery engine which processes the voice signals to compensate for the lost voice signals.

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16. The signal processing system of claim 1 wherein the voice exchange comprises a voice encoder capable of encoding the voice signals from the network line for transmission on the packet based network, and a voice activity detector which suppresses the voice signals without speech.

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Sub A10 17. The signal processing system of claim 16 further comprising a comfort noise estimator which generates comfort noise parameters when the voice activity detector suppresses the voice signals without speech.

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Sub A15 18. The signal processing system of claim 1 wherein the voice exchange further comprises a decoder capable of decoding packets of the voice signals from the packet based network, and an echo canceller capable of cancelling decoded voice signal echos on incoming voice signals from the network line.

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Sub A19 19. The signal processing system of claim 18 further comprising a non-linear processor which mutes the incoming voice signals when the incoming voice signals do not comprise speech and the echo canceller detects the decoded voice signals with speech.

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Sub A20 20. The signal processing system of claim 1 wherein the voice exchange comprises a voice encoder capable of encoding the voice signals from the network line into voice signal packets for the packet based network.

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Sub A21 21. The signal processing system of claim 20 further comprising a tone exchange comprising a DTMF detector capable of detecting a DTMF signal from the network line and generating a DTMF packet for the packet based network in response to the DMTF signal, the DTMF detector muting the voice signal packets when a DTMF signal is detected.

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Sub A22 22. The signal processing system of claim 1 further comprising a fax exchange capable of exchanging fax signals from the network line with demodulated fax signals from the packet based network

23. The signal processing system of claim 22 wherein the fax signals from the network line are modulated by a voiceband carrier, and the fax exchange comprises a data pump capable of demodulating the fax signals from the network line for transmission on the packet

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based network, and remodulating the fax signals from the packet based network with the voiceband carrier for transmission on the network line.

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24. The signal processing system of claim 22 wherein the call discriminator is capable of discriminating the fax signals from the network line, the fax exchange being enabled for the fax signals.

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25. The signal processing system of claim 1 wherein the data exchange comprises a rate synchronizer capable of receiving data rate codes from the packet based network and setting a data rate of a telephony device coupled to the network line in response to the received data rate codes.

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26. A signal processing system, comprising:
a voice exchange capable of exchanging voice signals between a first telephony device and a packet based network;
a full duplex data exchange capable of exchanging data signals from a second telephony device with demodulated data signals from the packet based network; and
a call discriminator which selectively enables at least one of the voice exchange and the data exchange.

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27. The signal processing system of claim 26 wherein the call discriminator is capable of discriminating between the voice signals and the data signals, the voice exchange being enabled for the voice signals and the data exchange being enabled for the data signals.

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28. The signal processing system of claim 26 wherein the data signals from the second telephony device are modulated by a voiceband carrier, and the data exchange comprises a data pump capable of demodulating the data signals from the second telephony device for transmission on the packet based network and remodulating the data signals from the packet based network with the voiceband carrier for transmission to the second telephony device.

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29. The signal processing system of claim 28 wherein the data exchange comprises a jitter buffer capable of receiving packets of the data signals of varying delay from the packet based network and compensating for the delay variation of the data signal packets.

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30. The signal processing system of claim 29 wherein the jitter buffer outputs an isochronous stream of the received data signals.

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31. The signal processing system of claim 29 wherein the data pump is capable of transmitting the received data signals to the second telephony device at a transmit rate.

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32. The signal processing system of claim 31 wherein the jitter buffer compensates for the delay variation of the data signal packets by holding a number of the received data signals, and wherein the data exchange further comprises a clock synchronizer which adaptively adjusts the transmit rate of the data pump in response to the number of the received data signals in the jitter buffer.

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33. The signal processing system of claim 31 wherein the jitter buffer compensates for the delay variation of the data signal packets by holding a number of the received data signals, and wherein the data exchange further comprises spoof logic which provides spoof data to the data pump when the number of the received data signals held in the jitter buffer is below a threshold.

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34. The signal processing system of claim 26 wherein the voice exchange comprises a jitter buffer capable of receiving packets of the voice signals of varying delay from the packet based network and compensating for the delay variation of the voice signal packets.

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35. The signal processing system of claim 34 wherein the jitter buffer outputs an isochronous stream of the received voice signals.

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36. The signal processing system of claim 34 wherein the jitter buffer comprises a voice queue which buffers the received voice signals for a holding time, and a voice synchronizer which adaptively adjusts the holding time of the voice queue.

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37. The signal processing system of claim 36 further comprising a tone exchange capable of exchanging DTMF signals between the first telephony device and the packet based network, the DTMF exchange comprising a DTMF queue capable of buffering packets of the DTMF signals from the packet based network, and a tone generator which generates a DTMF tone responsive to the buffered DTMF signals, the DTMF queue outputting a signal to the voice synchronizer to suppress the buffered voice signals when the DTMF signals are in the DTMF queue.

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38. The signal processing system of claim 26 wherein the voice exchange comprises a voice decoder capable of decoding packets of the voice signals from the packet based network for transmission to the first telephony device, a voice activity detector which detects the voice

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signals without speech, and a comfort noise generator which inserts comfort noise in place of the voice signals without speech.

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39. The signal processing system of claim 38 wherein the voice exchange further comprises a comfort noise estimator which generates comfort noise parameters from at least a portion of the voice signals without speech, the comfort noise generator being responsive to the comfort noise parameters.

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40. The signal processing system of claim 26 wherein the voice exchange comprises a voice decoder capable of decoding packets of the voice signals from the packet based network for transmission to the first telephony device, a voice activity detector which detects lost voice signals, and a lost packet recovery engine which processes the voice signals to compensate for the lost voice signals.

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41. The signal processing system of claim 26 wherein the voice exchange comprises a voice encoder capable of encoding the voice signals from the first telephony device for transmission on the packet based network, and a voice activity detector which suppresses the voice signals without speech.

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42. The signal processing system of claim 41 wherein the voice exchange further comprises a comfort noise estimator which generates comfort noise parameters when the voice activity detector suppresses the voice signals without speech.

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43. The signal processing system of claim 26 wherein the voice exchange further comprises a decoder capable of decoding packets of the voice signals from the packet based network, and an echo canceller capable of cancelling decoded voice signal echos on incoming voice signals from the first telephony device.

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44. The signal processing system of claim 43 wherein the voice exchange further comprises a non-linear processor which mutes the incoming voice signals when the incoming voice signals do not comprise speech and the echo canceller detects the decoded voice signals with speech.

45. The signal processing system of claim 26 wherein the voice exchange comprises a voice encoder capable of encoding the voice signals from the first telephony device into voice signal packets for the packet based network.

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46. The signal processing system of claim 45 further comprising a tone exchange comprising a DTMF detector capable of detecting a DTMF signal from the first telephony device and generating a DTMF packet for the packet based network in response to the DMTF signal, the DTMF detector muting the voice signal packets when a DTMF signal is detected.

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47. The signal processing system of claim 26 further comprising a fax exchange capable of exchanging fax signals from a third telephony device with demodulated fax signals from the packet based network, wherein the call discriminator selectively enables the fax exchange.

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48. The signal processing system of claim 47 wherein the fax signals from the third telephony device are modulated by a voiceband carrier, and the fax exchange comprises a data pump capable of demodulating the fax signals from the third telephony device for transmission on the packet based network, and remodulating the demodulated fax signals from the packet based network with the voiceband carrier for transmission to the third telephony.

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49. A method of processing signals, comprising:
exchanging voice signals between a network line and a packet based network; and
simultaneously exchanging data signals from the network line with demodulated data signals from the packet based network.

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50. The method of claim 49 further comprising discriminating between the voice signals and the data signals from the network line, and selectively invoking at least one of the voice signal exchange and the data signal exchange based on said discrimination.

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51. The method of claim 49 wherein the data signals from the network line are modulated by a voiceband carrier, and the data exchange comprises demodulating the data signals from the network line for transmission on the packet based network and remodulating the data signals from the packet based network with the voiceband carrier for transmission on the network line.

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52. The method of claim 49 wherein the voice exchange further comprises receiving packets of the signals of varying delay from the packet based network, and compensating for the delay variation of the signal packets.

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53. The method of claim 52 wherein the signal packet compensation comprises generating an isochronous stream of the received signals.

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54. The method of claim 52 wherein the signal packet compensation comprises adaptively buffering the received signals.

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55. The method of claim 49 wherein the voice signal exchange comprises receiving packets of the voice signals from the packet based network, identifying the received voice signals without speech, and inserting comfort noise in place of the identified voice signals without speech.

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56. The method of claim 55 wherein the comfort noise insertion comprises estimating comfort noise in response to at least a portion of the received voice signals without speech.

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57. The method of claim 49 wherein the voice signal exchange comprises receiving packets of the voice signals from the packet based network, detecting lost voice signals, decoding the received voice signals for transmission to the network line, and processing the decoded voice signals to compensate for the lost voice signals.

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58. The method of claim 49 further comprising exchanging DTMF signals between the network line and the packet based network.

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59. The method of claim 58 wherein the DTMF signal exchange comprises receiving packets of the DTMF signals from the packet based network, and generating at least one DTMF tone from the DTMF signals.

60. The method of claim 59 wherein the voice signal exchange comprises receiving packets of the voice signals from the packet based network, and the DTMF signal exchange further comprises muting the received voice signals when the DTMF signal packets are received.

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61. The method of claim 49 wherein the voice signal exchange comprises decoding packets of the voice signals from the packet based network, receiving voice signals from the network line and canceling decoded voice signal echos on the received voice signals.

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62. The method of claim 49 wherein the voice signal exchange comprises encoding the voice signals from the network line into voice signal packets for transmission on the packet based network.

63. The method of claim 62 further comprising exchanging DTMF signals between the network line and the packet based network, wherein the DTMF signal exchange comprises

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detecting DTMF signals from the network line, generating DTMF signal packets for the packet based network in response to the DTMF signals, and muting the voice signal packets when the DTMF signals are detected..

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64. The method of claim 49 wherein the voice signal exchange comprises receiving the voice signals from the network line and suppressing the received voice signals when the received voice signals do not comprise speech.

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65. The method of claim 64 wherein the suppression of the received voice signals comprises generating comfort noise parameters in place thereof.

66. The method of claim 49 further comprising exchanging fax signals from the network line with demodulated fax signals from the packet based network

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67. The method of claim 66 wherein the fax signals from the network line are modulated by a voiceband carrier, and the fax exchange comprises demodulating the fax signals from the network line for transmission on the packet based network and remodulating the fax signals from the packet based network with the voiceband carrier for transmission on the network line.

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68. The method of claim 67 wherein the signal discrimination further comprises discriminating the fax signals from the network line, and selectively invoking the fax exchange based on said discrimination.

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69. The method of claim 49 wherein the data signal exchange further comprises receiving packets of the data signals from the packet based network, holding a number of the received data signals in a buffer, and generating spoof data when the number of the data signals in the buffer is below a threshold.

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70. The method of claim 49 wherein the data signal exchange further comprises receiving packets of the data signals from the packet based network, holding a number of the received data signals in a buffer, transmitting the buffered data signals to the network line at a transmit rate, and adaptively adjusting the transmit rate in response the number of the received data signals in the buffer.

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71. The method of claim 49 wherein the data signal exchange further comprises receiving data rate codes from the packet based network, and setting a data rate of a telephony device coupled to the network line in response to the received data rate codes.

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72. The method of claim 49 wherein the network line comprises a circuit switched network line.

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73. The method of claim 72 wherein the circuit switched network line comprises a public switching telephone network line.

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74. A method of processing signals, comprising:
exchanging voice signals between a first telephony device and a packet based network;
simultaneously exchanging data signals from a second telephony device with demodulated data signals from the packet based network; and
discriminating between the voice signals and the data signals, and invoking at least one of the voice exchange and the data exchange based on said discrimination.

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75. The method of claim 74 wherein the data signals from the second telephony device are modulated by a voiceband carrier, and the data exchange comprises demodulating the data signals from the second telephony device for transmission on the packet based network and remodulating the data signals from the packet based network with the voiceband carrier for transmission to the second telephony device.

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76. The method of claim 74 further comprising receiving packets of the signals of varying delay from the packet based network, and compensating for the delay variation of the signal packets.

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77. The method of claim 76 wherein the signal packet compensation comprises generating an isochronous stream of the received signals.

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78. The method of claim 76 wherein the signal packet compensation comprises adaptively buffering the received signals.

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79. The method of claim 74 wherein the voice signal exchange comprises receiving packets of the voice signals from the packet based network, identifying the received voice signals

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without speech, and inserting comfort noise in place of the identified voice signals without speech.

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80. The method of claim 79 wherein the comfort noise insertion comprises estimating comfort noise in response to at least a portion of the received voice signals without speech.

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81. The method of claim 74 wherein the voice signal exchange comprises receiving packets of the voice signals from the packet based network, detecting lost voice signals, decoding the received voice signals for transmission to the first telephony device, and processing the decoded voice signals to compensate for the lost voice signals.

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82. The method of claim 74 wherein the signal discrimination further comprises discriminating between the voice signals, the data signals, and DTMF signals, and further comprising exchanging the discriminated DTMF signals between the first telephony device and the packet based network.

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83. The method of claim 82 wherein the DTMF signal exchange comprises receiving packets of the DTMF signals from the packet based network, and generating at least one DTMF tone from the DTMF signals.

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84. The method of claim 83 wherein the voice signal exchange comprises receiving packets of the voice signals from the packet based network, and the DTMF signal exchange further comprises muting the received voice signals when the DTMF signal packets are received.

85. The method of claim 74 wherein the voice signal exchange comprises decoding packets of the voice signals from the packet based network, receiving voice signals from the first telephony device and canceling decoded voice signal echos on the received voice signals.

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86. The method of claim 74 wherein the voice signal exchange comprises encoding the voice signals from the first telephony device into voice signal packets for transmission on the packet based network.

87. The method of claim 86 further comprising exchanging the DTMF signals between the first telephony device and the packet based network, wherein the DTMF signal exchange comprises detecting DTMF signals from the first telephony device, generating DTMF signal packets for the packet based network in response to the DTMF signals, and muting the voice signal packets when the DTMF signals are detected.

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88. The method of claim 74 wherein the voice signal exchange comprises receiving the voice signals from the first telephony device and suppressing the received voice signals when the received voice signals do not comprise speech.

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89. The method of claim 88 wherein the suppression of the received voice signals comprises generating comfort noise parameters in place thereof.

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90. The method of claim 74 wherein further comprising exchanging fax signals from a third telephony device with demodulated fax signals from the packet based network, wherein the signal discrimination comprises selectively invoking the fax exchange.

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91. The method of claim 90 wherein the fax signals from the third telephony device are modulated by a voiceband carrier, and the fax exchange comprises a data pump capable of demodulating the fax signals from the third telephony device for transmission on the packet based network, and remodulating the fax signals from the packet based network with the voiceband carrier for transmission to the third telephony device.

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92. The method of claim 74 wherein the data signal exchange further comprises receiving packets of the data signals from the packet based network, holding a number of the received data signals in a buffer, and spoofing the second telephony device when the number of the data signals in the buffer is below a threshold.

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93. The method of claim 74 wherein the data signal exchange further comprises receiving packets of the data signals from the packet based network, holding a number of the received data signals in a buffer, transmitting the buffered data signals to the second telephony device at a transmit rate, and adaptively adjusting the transmit rate in response the number of the received data signals in the buffer.

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94. The method of claim 74 wherein the data signal exchange further comprises receiving data rate codes from the packet based network, and setting a data rate of the second telephony device in response to the received data rate codes.

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95. A signal transmission system, comprising:

- a first telephony device which transmits and receives voice signals;
- a second telephony device different from the first telephony device;
- a packet based network; and

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a signal processing system coupling the first and the second telephony devices to the packet based network, the signal processing system comprising a full duplex data exchange which exchanges data signals from the second telephony device with demodulated data signals from the packet based network.

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96. The signal transmission system of claim 95 further comprising a circuit switched network coupling the first and the second telephony devices to the signal processing system.

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97. The signal transmission system of claim 96 wherein the circuit switched network comprises a public switching telephone network.

98. The signal transmission system of claim 95 wherein the packet based network comprises internet protocol.

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99. The signal transmission system of claim 95 wherein the packet based network comprises frame relay.

100. The signal transmission system of claim 95 wherein the packet based network comprises asynchronous transfer mode.

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101. The signal transmission system of claim 95 wherein the packet based network comprises a time division multiplexing network.

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102. The signal transmission system of claim 95 wherein the data signals from the second telephony are modulated by a voiceband carrier, and the data exchange comprises a data pump which demodulates the data signals from the second telephony device for transmission on the packet based network and remodulates the data signals from the packet based network with the voiceband carrier for transmission to the second telephony device.

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103. The signal transmission system of claim 95 wherein the data exchange comprises a jitter buffer which receives packets of the data signals of varying delay from the packet based network and compensates for the delay variation of the data signal packets.

104. The signal transmission system of claim 103 wherein the jitter buffer outputs an isochronous stream of the received data signals.

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105. The signal transmission system of claim 103 wherein the data pump transmits the received data signals to the second telephony device at a transmit rate.

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106. The signal transmission system of claim 105 wherein the jitter buffer compensates for the delay variation of the data signal packets by holding a number of the received data signals, and wherein the data exchange further comprises a clock synchronizer which adaptively adjusts the transmit rate of the data pump in response the number of the received data signals in the jitter buffer.

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107. The signal transmission system of claim 103 wherein the jitter buffer compensates for the delay variation of the data signal packets by holding a number of the received data signals, and wherein the data exchange further comprises spoof logic which provides spoof data to the data pump when the number of the received data signals held in the jitter buffer is below a threshold.

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108. The signal transmission system of claim 95 wherein the signal processing system further comprises a voice exchange which exchanges the voice signals between the first telephony device and the packet based network.

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109. The signal transmission system of claim 108 wherein the signal processing system further comprises a call discriminator which discriminates between a first telephony device transmission and a second telephony device transmission, the call discriminator invoking at least one of the voice exchange and the data exchange based on said discrimination.

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110. The signal transmission system of claim 108 wherein the voice exchange comprises a jitter buffer which receives packets of the voice signals of varying delay from the packet based network and compensates for the delay variation of the voice signal packets.

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111. The signal transmission system of claim 110 wherein the jitter buffer outputs an isochronous stream of the received voice signals.

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112. The signal transmission system of claim 110 wherein the jitter buffer comprises a voice queue which buffers the received voice signals for a holding time, and a voice synchronizer which adaptively adjusts the holding time of the voice queue.

113. The signal transmission system of claim 112 wherein the signal processing system further comprises a tone exchange which exchanges DTMF signals between the first telephony

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device and the packet based network, the DTMF exchange comprising a DTMF queue which buffers packets of the DTMF signals from the packet based network, and a tone generator which generates a DTMF tone responsive to the buffered DMTF signals, the DMTF queue outputting a signal to the voice synchronizer to suppress the buffered voice signals when the DTMF signals are in the DTMF queue.

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114. The signal processing system of claim 108 wherein the voice exchange comprises a voice decoder which decodes packets of the voice signals from the packet based network for transmission to the first telephony device, a voice activity detector which detects the voice signals without speech, and a comfort noise generator which inserts comfort noise in place of the voice signals without speech.

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115. The signal processing system of claim 114 wherein the voice exchange further comprises a comfort noise estimator which generates comfort noise parameters from at least a portion of the voice signals without speech, the comfort noise generator being responsive to the comfort noise parameters.

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116. The signal processing system of claim 108 wherein the voice exchange comprises a voice decoder which decodes packets of the voice signals from the packet based network for transmission to the first telephony device, a voice activity detector which detects lost voice signals, and a lost packet recovery engine which processes the voice signals to compensate for the lost voice signals.

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117. The signal processing system of claim 108 wherein the voice exchange comprises a voice encoder which encodes voice signals from the first telephony device for transmission on the packet based network, and a voice activity detector which suppresses the voice signals without speech.

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118. The signal processing system of claim 117 further comprising a comfort noise estimator which generates comfort noise parameters when the voice activity detector suppresses the voice signals without speech.

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119. The signal processing system of claim 108 wherein the voice exchange further comprises a decoder which decodes packets of the voice signals from the packet based network, and an echo canceller which cancels decoded voice signal echos on incoming voice signals from the first telephony device.

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120. The signal processing system of claim 119 further comprising a non-linear processor which mutes the incoming voice signals when the incoming voice signals do not comprise speech and the echo canceller detects the decoded voice signals with speech.

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121. The signal processing system of claim 108 wherein the voice exchange comprises a voice encoder which encodes the voice signals from the first telephony device into voice signal packets for the packet based network.

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122. The signal processing system of claim 121 further comprising a tone exchange comprising a DTMF detector which detects a DTMF signal from the first telephony device and generates a DTMF packet for the packet based network in response to the DMTF signal, the DTMF detector muting the voice signal packets when the DTMF signal is detected.

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123. The signal transmission system of claim 95 further comprising a third telephony device coupled to the signal processing system.

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124. The signal transmission system of claim 123 wherein the third telephony comprises a fax.

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125. The signal processing system of claim 124 further comprising a fax exchange which exchanges fax signals from the third telephony device with demodulated data signals from the packet based network.

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126. The signal processing system of claim 125 wherein the fax signals from the third telephony device are modulated by a voiceband carrier, and the fax exchange comprises a data pump which demodulates the fax signals from the third telephony device for transmission on the packet based network and remodulates the fax signals from the packet based network with the voiceband carrier for transmission to the third telephony device.

127. The signal transmission system of claim 95 wherein the first telephony device comprises a telephone.

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128. The signal transmission system of claim 95 wherein the second telephony device comprises a modem.

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